much better than those which would be obtained if actual mouth-to-mouth inflation (Elisha's method ! see 2 Kings, iv, 34) were attempted.

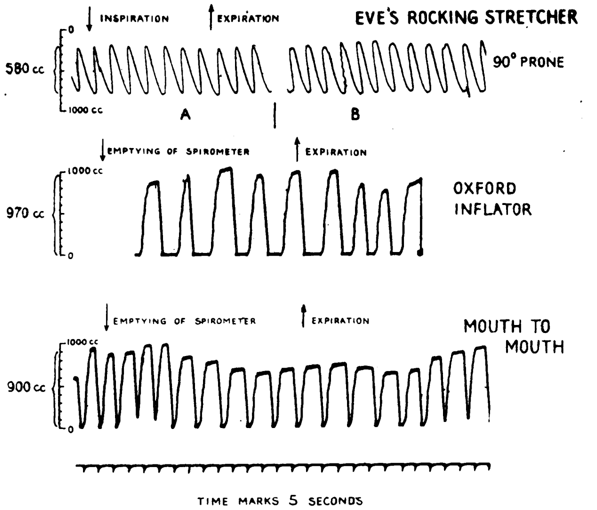

FIG. 3

Discussion

Our figures (see Table) probably show the various methods of artificial respiration at their best. A clear airway was maintained throughout by a wide-bore endotracheal cuff-tube. The subjects were healthy young males, and the operator highly skilled.

Tidal Exchange with Various Methods of Artificial Respiration

Method	Tidal Exchange in ml.	
	E. A. P. (Wt. 10 st.)	J. R. (Wt. 13 st.)
Eve's rocking:		
On back 60°	240	570
On back 90°	380	635
On face 60°	340	725
On face 90°	580	850
Schäfer	340	530
Silvester	400	650
"Mouth-to-mouth" inflation	900	1,030
Oxford inflator	970	1,550

Eve (1943) claims that the venous return to the heart, and therefore the output from the heart, are improved more by his method than by others. The figures we give record only pulmonary ventilation.

We believe that in artificial respiration too much stress has been laid on unimportant outward details and not enough on absolute essentials such as the maintenance of a clear airway. The choice of any particular method appears to us relatively unimportant. If the subject is dead no method will be available, and, speaking broadly, if a spark of life still exists any method, properly carried out, will probably suffice.

Waters and Bennett (1936) recorded the figures of artificial respiration carried out under deep surgical anaesthesia, and we can agree with their observation that "an apnoeic patient under deep anaesthesia simulates the candidate for resuscitation by artificial respiration."

REFERENCES

Eve, F. C. (1943). *British Medical Journal*, **1**, 535.
Henderson, Yandell (1938). *Adventures in Respiration*, p. 273, Baltimore and London.
Macintosh, R. R., and Pratt, C. L. G. (1939). *Lancet*, **1**, 206.
Waters, R. M., and Bennett, J. H. (1936). *Anesth. & Analges.*, **15**, 151.

The report of a rural life conference held at Newbury at the beginning of the year has been issued under the title *The Science of Relationships* from C.M. House, 6, Salisbury Square, London, E.C.4, price 2s. The object of the discussion was to counteract one-sided development by fostering closer contact between workers in different callings, and to promote a unified programme of action. It was attended by people interested in medicine and nutrition, and among the papers was one by Prof. J. Scott Watson on "Agriculture, Food, and Society," which dealt with nutritional problems.

OBSERVATIONS ON NORMAL BODY TEMPERATURES IN NORTH INDIA

BY

E. T. RENBOURN, M.D., B.Sc., M.R.C.P.
Major, R.A.M.C.; Biological Research Team, India Command

WITH A STATISTICAL ANALYSIS BY

F. F. BONSALL, B.A.
Capt., R.E.

(From the User Trials Establishment, India)

The effect of hot climates on normal body temperature has for long been a controversial problem among students of climatic physiology. Castellani (1938) denies that body temperature is affected by journeys to the Tropics or residence there. Sundstroem (1927), and more recently Radsma *et al.* (1938) and Mason (1940), find a higher mean temperature of Europeans in tropical climates. The present data represent some 1,800 temperature records taken during the period March–September, 1945, in North India (Dehra Dun).

Method

In this investigation 21 ordinary clinical thermometers were used. The standard deviation for these corrected to 98.6° F. was 0.12° F.

For resting temperatures, individuals were used who were on normal military duties, had not marched during that day, and had rested for half an hour in the shade. Meals had not been taken for at least one hour. The clothing worn in all cases was khaki drill. Oral temperatures were taken (*a*) under the tongue with the mouth firmly closed, and (*b*) with the thermometer placed as far as possible into the rectum. Where oral and rectal temperatures were done on the same individual these were taken simultaneously, a period of at least three minutes being allowed. All readings were taken in the upright position. Where possible, temperatures were taken in the laboratory, otherwise in the open out of the sun. Individuals were not selected in any way, but no mechanical method of random sampling was used. All British personnel had been in the area for at least four months, and most for one to two years.

The Frequency Distribution of Resting Oral Temperatures

Table I represents the analysis of 9 groups of individuals whose oral temperatures were taken at different times of the day during the monsoon period. The frequency histograms of the groups are shown in Figs. 1 to 9. The wet- and dry-bulb readings were taken at the time of examination. The mean for the whole group of 894 individuals is 98.75° F.; standard deviation, 0.50; and S.E. mean, 0.017. The corresponding figures found by Whiting (1915–17) for 500 criminals in England were: mean, 98.38° F.; S.D., 0.486; S.E. mean, 0.011.

Examination of the skewness figures in Table I shows that some of the samples differ significantly from the normal distribution. There is, however, no evidence of skewness in the total population of temperatures. The fact is that the samples are far from being random samples. There is no evidence from the data that oral temperatures are not normally distributed.

The figures for the standard error of the mean show that the means of some of our samples vary significantly. They also show that the mean temperatures for Serials 1–5 are significantly high compared with the "normal" temperature of 98.4° F. No other meaning should be attached to the standard errors owing to the fact that our samples are not random samples from the total population of temperatures. The low mean of Serial 6 may be explained by the fact that these men were examined just after a heavy shower. This point is discussed later.

Man-to-Man and Diurnal Variation of Resting Temperatures

The first set of data considered here is quoted in full in Table II. It consists of oral and rectal temperatures of 12 normal Indian soldiers taken at five different times during the day on Aug. 8, 1945. The men belonged to one unit, experienced approximately the same external conditions during the day, and were on the same light duty.

Examination of Table II shows that the mean oral temperature for the 12 men rises steadily from 98.79° at 8.30 a.m. to 99.43° at 7.30 p.m., and the means for the individual men vary between 98.58° and 99.66° F. It is clear that the observed variation may not be entirely haphazard but may be partly due to differences

TABLE I.—*Analysis of Oral Temperatures of 9 Groups taken during the Monsoon Period*

Serial	Race	Sample Size	Date and Time	Dry- and Wet-bulb ° F.	Mean ° F.	Standard Deviation	Skewness (d)	Standard Error Mean	Standard Error S.D.	Standard Error Skewness
1	Indian (Travancore)	100	29/6/45 11.15 a.m./12.15 p.m.	95/80	98·86	0·36	−0·11	0·036	0·026	0·044
2	Indian (Punjabi)	108	29/6/45 3 p.m./4 p.m.	95/82	98·88	0·43	Not sig.	0·042	0·029	—
3	Gurkha	150	29/6/45 5 p.m./6 p.m.	94/80	98·92	0·49	+0·10	0·040	0·029	0·049
4	British	120	4/7/45 2 p.m./4 p.m.	95/78	98·94	0·49	Not sig.	0·045	0·032	—
5	Indian (Mixed)	105	5/7/45 2.30 p.m./4 p.m.	85/74	98·87	0·37	+0·25	0·039	0·028	0·047
6	British	73	6/7/45 2 p.m./3 p.m.	78/72	98·13	0·62	−0·37	0·071	0·051	0·088
7	British	115	6/7/45 3.30 p.m./4.30 p.m.	79/72	98·62	0·38	Not sig.	0·035	0·025	—
8	Gurkha	70	24/7/45 8.30 a.m./9 a.m.	82/76	98·58	0·37	Not sig.	0·044	0·031	—
9	Indian (Punjabi)	53	24/7/45 8.30 a.m./9 a.m.	88/72	98·45	0·43	+0·18	0·059	0·042	0·072
	Total	894			98·75	0·50	Not sig.	0·017	0·012	—

NOTE.—The statistics above have been calculated from the moments of the distributions. The estimates of the standard deviation and skewness so obtained are inaccurate for small samples, but are sufficiently accurate for the samples used here.

TABLE II.—*Simultaneous Oral and Rectal Temperatures (° F.) of 12 Indian Soldiers taken on Aug. 8, 1945*

Man	T1 8.30 a.m. Oral	T1 8.30 a.m. Rectal	T2 11 a.m. Oral	T2 11 a.m. Rectal	T3 2 p.m. Oral	T3 2 p.m. Rectal	T4 5 p.m. Oral	T4 5 p.m. Rectal	T5 7.30 p.m. Oral	T5 7.30 p.m. Rectal	Mean Oral	Mean Rectal
M1 ..	99·4	99·8	99·0	100·0	99·0	99·6	99·2	99·8	100·0	100·2	99·32	99·88
M2 ..	98·4	99·0	98·6	99·6	98·9	—	99·2	100·0	99·0	100·0	98·82	99·65
M3 ..	99·0	99·4	99·0	99·6	99·0	99·7	99·2	100·4	99·2	100·5	99·08	99·92
M4 ..	99·4	99·6	99·5	100·6	99·3	100·0	99·5	100·5	100·6	101·0	99·66	100·24
M5 ..	98·9	99·4	98·8	100·1	99·2	100·0	99·2	100·3	99·6	100·7	99·14	100·10
M6 ..	98·2	98·4	98·6	99·4	98·6	99·4	98·4	99·4	99·2	99·8	98·60	99·28
M7 ..	98·6	(98·4)	99·0	99·6	98·8	99·8	99·0	(98·4)	99·2	99·6	98·92	99·20
M8 ..	99·0	(98·2)	98·8	100·0	98·6	99·2	99·0	99·8	99·2	100·5	98·92	99·54
M9 ..	98·2	98·8	98·4	98·8	98·7	99·0	99·0	99·4	98·6	99·6	98·58	99·12
M10 ..	99·2	99·9	98·6	100·0	99·4	100·0	99·7	100·0	99·6	100·2	99·30	100·02
M11 ..	98·5	99·2	98·9	100·0	98·8	100·3	99·2	99·8	99·4	100·6	98·96	99·98
M12 ..	98·7	99·6	98·6	99·6	99·0	100·2	98·8	99·6	99·6	100·0	98·94	99·80
Mean	98·79	99·14	98·82	99·78	98·94	99·74	99·12	99·78	99·43	100·23	99·02	99·73

NOTE.—The brackets signify that the oral temperature is above rectal.

TABLE IIA.—*Simultaneous Oral and Rectal Temperatures (° F.) of 14 British Personnel taken at 5 p.m. on July 4, 1945*

Man :	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Oral	99·4	99·2	99·8	100·0	99·6	99·6	99·6	99·8	99·6	99·2	99·4	99·6	99·8	99·6
Rectal ..	101·0	101·0	100·4	100·4	100·2	100·6	100·2	100·8	100·0	100·0	101·0	100·4	100·6	100·6

between men and partly to systematic changes during the day in addition to haphazard variation.

To test this hypothesis we divide the total variance into three parts: variance of man-to-man variation, time-to-time variation, and haphazard or " error " variation (Table III).

TABLE III

Type of Variation	Variance	Degrees of Freedom for Estimate
Man-to-man	0·47090	11
Time-to-time	0·83933	4
Error	0·05769	44

If there is no significant variation man to man our estimate for the man-to-man variance will not differ significantly from our estimate of the error variance. The significance of the time-to-time variation is tested in the same way. The test of significance used is the Z test (Fisher and Yates's *Statistical Tables*). With this set of data we have:

(*a*) *Man-to-Man Variation:*

$$e^{2z} = \frac{\text{man-to-man variance}}{\text{error variance}} = 8.163, \text{ from which } p < 0.1\%.$$

The probability (p) that this value of e^{2z} should arise through chance is less than one in a thousand.

It is clear, therefore, that the differences between men are significant.

(*b*) *Time-to-time Variation:*

A similar calculation gives:

$$e^{2z} = 14.55;\ p < 0.1\%,$$

which shows that the differences between times are also significant.

We have thus shown that for our group of 12 men there are significant differences between men and that significant changes take place in the temperature of the group during the day. Another way of expressing this result is to say that each man has his own characteristic range of temperature and that there is a strong tendency for all the temperatures in the group to vary together. On this particular day they all tend to increase. This tendency for the temperatures of all men in the group to vary together may be explained in two ways. It may be due to some internal rhythm or, since all the men experience the same external conditions, it may be due to some change in the external conditions—for instance, the air temperature.

Rectal temperatures were taken at the same times for the same group of 12 Indian soldiers (Table II). Analysing these data in exactly the same manner gives:

TABLE IV

Type of Variation	Variance	Degrees of Freedom	Variance Ratio e^{2z}	p
Man-to-man	0·75433	11	5·67	<0·1%
Time-to-time	1·57063	4	11·81	<0·1%
Error	0·13303	44		

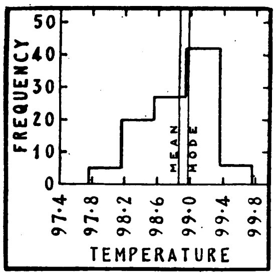

FIG. 1.—Serial 1 (Table I). Mean, 98.86°; mode, 98.97°. Significant skewness.

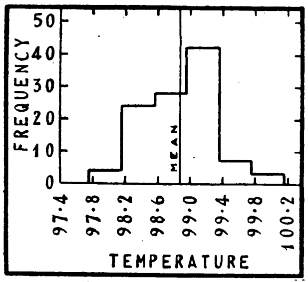

FIG. 2.—Serial 2. Mean, 98.88°. No significant skewness.

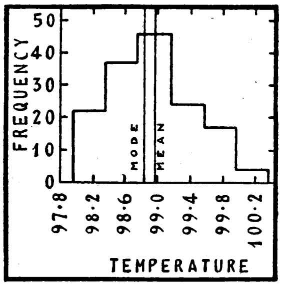

FIG. 3.—Serial 3. Mean, 98.92°; mode, 98.81°. Significant skewness.

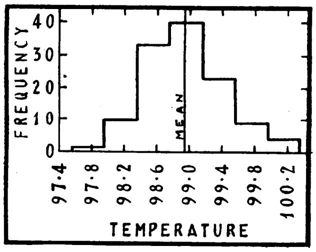

FIG. 4.—Serial 4. Mean, 98.94°. No significant skewness.

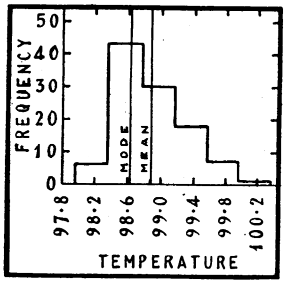

FIG. 5.—Serial 5. Mean, 98.87°; mode, 98.62°. Significant skewness.

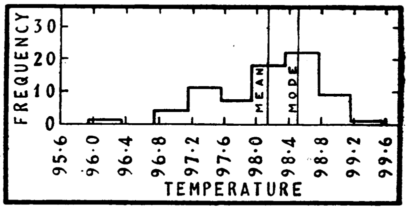

FIG. 6.—Serial 6. Mean, 98.13°; mode, 98.51°. Significant skewness.

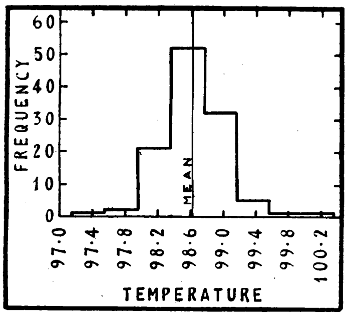

FIG. 7.—Serial 7. This group consisted of British troops who had been two years or more in India. Mean, 98.62°. No significant skewness.

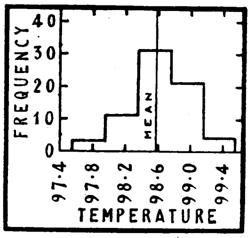

FIG. 8.—Serial 8. Mean, 98.58°. No significant skewness.

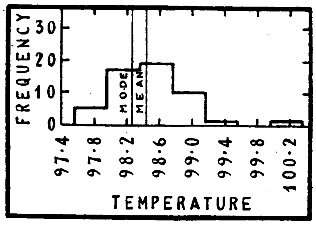

FIG. 9.—Serial 9. Mean, 98.45°; mode, 98.26°. Significant skewness.

The means for the group at the five times are:

T 1	T 2	T 3	T 4	T 5
99·14°	99·78°	99·74°	99·78°	100·23°

The results for rectal temperatures are therefore almost exactly the same as for oral temperatures.

Correlation of Resting Oral and Rectal Temperatures

Correlating the two sets of data for oral and rectal temperatures of the same 12 Indian men used in Table II, we obtain:

Correlation coefficient $r = 0.6605$; $p < 0.1\%$.

This indicates that there is a positive and significant correlation between oral and rectal temperatures. It may be objected that this apparent correlation may be entirely due to the correlation of both oral and rectal temperatures with time. We therefore calculate the partial correlation coefficient with time eliminated:

Partial correlation coefficient $r_t = 0.5258$; $p < 0.1\%$

This shows that even when time is eliminated there is a positive and significant correlation of oral and rectal temperatures. If at any time, therefore, a normal man is found to have an unusually high oral temperature we may also expect with reasonable confidence to find an unusually high rectal temperature.

Some doubt is thrown on this conclusion by a second set of data. On July 4 oral temperatures of a large group of British troops were taken, and rectal temperatures of the first 14 men found to have oral temperatures over 99° F. (see Table IIA). The correlation coefficient found for this set of data is not significant. The reason for the absence of correlation in this case is probably that the sampling technique imposes too close a restriction on the variation of oral temperatures.

Another set of similar data concerns 20 normal British soldiers whose temperatures were taken four times during a day, on Aug. 24 (Table V). The analysis is given in Table VI.

TABLE V.—*20 Normal British Soldiers*

Time:	9 a.m.	12.30 p.m.	2.30 p.m.	5 p.m.
Minimum oral temp.; ° F.	98·2	98·0	98·3	98·3
Maximum " " "	99·3	98·8	100·0	100·1
Mean " " "	98·82	98·43	99·015	98·93
Minimum rectal temp.; ° F.	99·0	98·3	99·1	98·4
Maximum " " "	100·0	99·3	100·3	100·8
Mean " " "	99·645	99·025	99·70	99·32

TABLE VI.—*Analysis of Table V*

	Type of Variation	Variance	Degrees of Freedom	Variance Ratio e^{2z}	p
Oral	Man-to-man	0·42986	19	5·13	<0·1%; sig.
	Time-to-time	1·33612	3	15·95	<0·1%; sig.
	Error	0·08375	57		
Rectal	Man-to-man	0·42102	19	3·63	<0·1%; sig.
	Time-to-time	1·96683	3	16·94	<0·1%; sig.
	Error	0·11613	57		

Inspection of Table VI shows that the results do not differ from those for the Indian troops.

An even higher value is found for the correlation of oral and rectal temperatures:

$r = 0.79504$; $p < 0.1\%$.

Eliminating the correlation of oral and rectal temperatures with time, we find the value of the partial correlation coefficient,

$$r_t = 0.75972; \; p < 0.1\%.$$

Seasonal Variation of Resting Oral Temperatures in Groups of Individuals

The oral temperatures of a number of small groups of British and Indian soldiers were taken at 10 a.m. on a number of days scattered irregularly over the period March to October. Tables VII and VIII show the results obtained:

TABLE VII.—*British Troops*

Month	Size of Sample	Mean (° F.)	S.E. of Mean
March	9	98·07	0·17
May	42	98·62	0·08
June/July	11	98·61	0·13
August/September ..	26	98·62	0·08
October	84	98·40	0·06

TABLE VIII.—*Indian Troops*

Month	Size of Sample	Mean (° F.)	S.E. of Mean
April	6	98·25	0·23
May	8	99·40	0·21
August	70	98·81	0·07
September	45	98·87	0·06
October	69	98·40	0·07

Tables VII and VIII show that the oral temperature taken at 10 a.m. rises in the period March to May, remains constant from May to September, and falls in September and October. The very high May figure for Indian troops is almost certainly a freak of chance due to the small size of the sample. These seasonal changes correspond closely to the changes in the 10 a.m. temperature at Dehra Dun.

Seasonal and Diurnal Variation of Resting Oral Temperature in an Individual

The oral temperatures of 7 individuals—4 British, 3 Indian—were taken at a number of fixed times during the day, and repeated on several days during the year. These data enable us to determine whether an individual has a characteristic variation in temperature during the 24 hours: is the oral temperature periodic, with a period of 24 hours ? It also enables us to determine whether there is any significant seasonal change not only in the mean oral temperature but in its 24-hour variability. The method of analysis is the same as that used in Table III, except that instead of sets of data for different men we have sets of data for the same man on different days. The data from 4 of the cases are analysed below.

First Case (British)

TABLE IX.—*Seasonal Variation*

Date:	May 6	June 14	Aug. 5	Sept. 7
Range oral temperature; ° F. ..	1·8	2·1	1·1	1·0
Mean „ „ „ ..	98·2	97·91	97·34	97·85
Variance; ° F.	0·56	0·60	0·14	0·14
Mean air temperature*; ° F. ..	85·5	91	80	79·5
Range† air „ „ ..	31	26	12	15

* Mean air temperature quoted is the approximate estimate $\frac{\text{max.} + \text{min.}}{2}$

† Range = max. − min.

TABLE X.—*Diurnal Variation*

Time:	7 a.m.	10 a.m.	1 p.m.	4 p.m.	7 p.m.	10 p.m.	12 p.m.	2 a.m.
Mean for 4 days; ° F.	97·23	98·33	98·18	98·18	98·43	97·88	97·43	96·98

Table IX shows that the mean oral temperature falls slightly from May to September, corresponding to the slight fall in mean air temperature. It also shows that there is a marked decrease in the variability of the oral temperature corresponding to the great decrease in air-temperature range during the monsoon period.

Table X shows that the oral temperature is periodic, with a maximum in the afternoon and a minimum in the very early morning, more or less corresponding to the 24-hour variation of air temperature.

TABLE XI.—*Significance*

Type of Variation	Variance	Degrees of Freedom	Variance Ratio e^{2z}	p
Seasonal	1·03083	3	12·98	$<0·1\%$; sig.
Diurnal	1·200	7	15·11	$<0·1\%$; sig.
Error	0·07940	21		

Table XI shows that the observed seasonal and diurnal variations are significant for this individual case. If similar results are obtained from other individual cases it will be reasonable to deduce that the oral temperature is influenced to an important extent by the air temperature.

Second Case (British)

TABLE XII.—*Seasonal Variation*

Date:	Mar. 20	May 6	June 14	Aug. 5	Sept. 9	Sept. 23
Range oral temperature; ° F.	1·9	2·0	1·0	1·7	1·4	1·1
Mean oral temperature; ° F.	97·51	97·83	97·94	98·08	97·65	97·44
Variance	0·46	0·51	0·14	0·30	0·20	0·16
Mean air temperature; ° F.	67	85·5	91	80	79	78
Range air temperature; ° F.	28	31	26	12	18	16

TABLE XIII.—*Diurnal Variation*

Time:	7 a.m.	10 a.m.	1 p.m.	4 p.m.	7 p.m.	10 p.m.	12 p.m.	2 a.m.
Mean for 6 days; °F.	97·08	97·98	97·9	98·18	98·42	97·75	97·48	97·12

TABLE XIV.—*Significance*

Type of Variation	Variance	Degrees of Freedom	Variance Ratio e^{2z}	p
Seasonal	0·49576	5	6·5568	$<0·1\%$; sig.
Diurnal	1·39282	7	18·4211	$<0·1\%$; sig.
Error	0·07561	35		

Tables XII, XIII, and XIV show that the variation of the second case is substantially the same as that of the first. Two figures in Table XII are not in accordance with expectation: the low variance on June 14 and the high mean on Aug. 5. Such deviation from expectation is, however, usual in data of this sort.

Third Case (Indian)

TABLE XV.—*Seasonal Variation*

Date:	April 2	May 2	July 30	Sept. 27
Range oral temperature; ° F. ..	3·0	3·0	1·8	2·4
Mean „ „ „ ..	98·47	98·47	98·8	98·22
Variance	1·07	0·99	0·40	0·57
Mean air temperature; ° F. ..	75	83	79	70·5
Range „ „ „ ..	22	30	14	11

TABLE XVI.—*Diurnal Variation*

Time:	7 a.m.	10 a.m.	1 p.m.	4 p.m.	7 p.m.	10 p.m.
Mean for 4 days; ° F.	96·95	98·6	98·88	99·13	99·13	98·25

TABLE XVII.—*Significance*

Type of Variation	Variance	Degrees of Freedom	Variance Ratio e^{2z}	p
Seasonal	0·34365	3	3·32253	$<5\%$; sig.
Diurnal	2·71675	5	26·26655	$<0·1\%$; sig.
Error	0·10343	15		

These results agree closely with expectation.

Fourth Case (British)

TABLE XVIII.—*Seasonal Variation*

Date:	Mar. 26	May 13	Aug. 3	Aug. 22	Sept. 9	Sept. 23
Range oral temperature; ° F.	1·6	2·2	1·5	1·4	1·4	1·5
Mean oral temperature; ° F.	97·94	97·83	98·21	97·66	97·58	98·27
Variance ..	0·38	0·89	0·29	0·24	0·23	0·32
Mean air temperature; ° F.	73·5	82·5	80·5	78	79	78
Range air temperature; ° F.	27	31	13	12	18	16

TABLE XIX.—*Diurnal Variation*

Time:	7 a.m.	10 a.m.	1 p.m.	4 p.m.	7 p.m.	10 p.m.	12 p.m.	2 a.m.
Mean for 6 days; ° F.	97·33	98·38	98·52	98·67	98·6	98·12	97·7	97·27

TABLE XX.—*Significance*

Type of Variation	Variance	Degrees of Freedom	Variance Ratio e^{2z}	p
Seasonal	0·25684	5	3·16422	$<5\%$; sig.
Diurnal	1·93857	7	23·88283	$<0·1\%$; sig.
Error	0·08117	35		

The agreement with expectation of the mean oral temperatures in Table XVIII is poor. The variance figures in Table XVIII are in accordance with expectation.

Effect of Exercise on Oral and Rectal Temperatures

Data from " Clothing " Trial—Oral Temperatures

Oral and rectal temperatures of a group of 13 British men were taken on five days—D1, D2, D3, D4, D5—at 9 a.m. and 12.30 p.m. in a period of 14 days (Aug. 24–Sept. 7). D1: the men rested indoors except for a 1½-mile march before 9 a.m. D2: the men marched 10 miles between 9 a.m. and 12.30 p.m.; heavy rain. D3: the men marched 10 miles between 9 a.m. and 12.30 p.m.; heavy rain. D4: the men marched 10 miles between 9 a.m. and 12.30 p.m.; no rain. D5: the men rested indoors.

The conditions of the march were as identical as possible on each of the march days—viz., route, load carried, clothing, and rate of marching. The wet- and dry-bulb temperatures at 9 a.m. and 12.30 p.m. did not vary more than 2–4° F.

TABLE XXI.—*Oral Temperatures*

Day:	D1	D2	D3	D4	D5
Mean rise or fall in oral temperature, 9 a.m. to 12.30 p.m.; ° F.	−0·3	−0·65	−0·31	+0·67	+0·22

The difference between these mean variations of temperature is significant ($p < 0·1\%$).

Comparing D1 and D5, we see that when the men rest indoors all day their temperature rises. When they rest after a march of only 1½ miles it falls. Comparing D4 and D5, we see that the rise in temperature is considerably greater if the men march 10 miles in dry warm conditions. A comparison of D2 and D3 with D4 shows that marching in the rain produces a fall in oral temperature instead of a rise.

It may be concluded that marching under dry warm conditions produces a rise in oral temperature but marching in the rain produces a fall. It is reasonable to deduce that exercise causes a rise in oral temperatures, while the cooling effect of rain produces a marked fall.

Data from " Clothing " Trial—Rectal Temperatures

The results are shown in Table XXII.

TABLE XXII.—*Rectal Temperatures*

Day:	D1	D2	D3	D4	D5
Mean rise or fall in rectal temperature, 9 a.m. to 12 noon; ° F.	−0·59	+0·95	+1·0	+1·65	+0·02

The differences between the mean rises in temperature are significant ($p < 0·1\%$).

Comparing D1 and D5, it is seen that the 1½-mile march before 9 a.m. produces a fall in rectal temperature between 9 a.m. and 12.30 p.m. as compared with a completely resting day. Comparing D2, D3, and D4 with D5, we see that a march under the conditions of the experiment produces a rise in rectal temperature whatever the weather. Comparing D2 and D3 with D4, it is seen that the rise in rectal temperature produced by a march is greater on a dry day than on a wet day.

It may be concluded that marching produces a rise in rectal temperature which is larger on a dry day than on a wet day. The rectal temperature is apparently less influenced by external conditions than is the oral temperature. Results from other field trials gave similar findings.

Discussion

Table I and the histograms shown in Figs. 1 to 9 demonstrate that under the particular conditions of the investigation oral temperatures higher than those accepted as normal for temperate climates are not uncommon during the summer in North India. Most authorities accept 97–99° F. as the normal range, but it is known that figures above or below may under certain conditions be accepted as normal resting temperatures. The total range for the 894 individuals is 96.7–100.4° F., and including data from Table II this becomes 96.3–100.6 ° F. for the period 8.30 a.m. to 7.30 p.m. Among the British personnel no correlation could be found between length of service and resting oral temperature. In all cases examined the resting pulse rates were normal, but routine pulse rates were not recorded. No correlation was found in two groups of about 200 individuals each, one British and one Indian, between the resting oral temperature and erythrocyte sedimentation rate done at the same time. Using data obtained from troop trials, an attempt was made to correlate the resting rectal temperature with the post-exercise pulse rate and the rise in rectal temperature in groups of men doing the same work under similar conditions. Scatter diagrams did not suggest any obvious correlations.

In a group of individuals whose physical efficiency was measured at various times, using the Harvard pack test, the individual whose score was invariably the highest also showed the highest summer temperature. There are no data available yet which in terms of physical efficiency or acclimatization throw light on this climatic rise in temperature. Although there are not enough data to warrant a valid comparison between the Indian and the British personnel, it would seem that the temperatures in Indians are not much different from those of the British (Tables I, VII, VIII). It does not appear, therefore, that acclimatization in the ordinary sense is an important factor. In this respect the condition known as prickly heat is of interest. It was a common finding during the early part of the monsoon period in both British and Indian personnel, but with a lower incidence in the latter. However, in neither group was any relationship found between the presence of prickly heat and the level of the resting oral temperature.

Mason (1940) concluded that the type of body response in the heat might explain why in some individuals the temperature rose in hot climates yet did not rise in others. She found that British and American women showed two types of response in the basal metabolic rate. In the first type this fell by about 10% with no significant change in oral temperature, and in the second the basal metabolic rate was unaffected but the temperature rose significantly (average 0.6° F.). Muscular relaxation is brought about more easily in a hot environment, and the basal rate in temperate and that in hot climates are strictly not comparable. If there were two types of response to climatic heat we might expect a bimodal frequency curve. This is not suggested by our findings. Out of the 9 distributions only Serials 1 and 4 have a definite appearance of being bimodal when grouped at 0.2° F. In both of them the modes occur at 98.4 and 99° F., and bias in favour of reading even figures on a thermometer may explain the apparent double mode. Data are not available as to the effect of a hot but very dry climate—viz., Iraq—on body temperature. It may not be the same as in North India, where low humidity is uncommon.

A point of practical importance is the clinical significance of raised body temperature in hot climates. The data in Table I were collected with the help of unit medical officers who were unaware of the fact that oral resting temperatures in both British and Indian troops could lie between 99 and 100° F. in the summer months. A few hours' bed rest does not necessarily alter the level of the daily temperature curve, but bed rest for more than 24 hours will usually do so. It is therefore likely that an individual with what may be called climatic fever will show, when convalescing from an infective process, a recurrence of his "normal" fever after he has been up for a day or so. Unless its significance is realized the individual may be retained in hospital for further investigation. Again, a man reporting sick with an oral temperature above 99° F. may have a condition which is in no way related to his temperature. There is evidence that climatic fever may have been a cause of some man-power wastage among Army personnel.

It is usually stated in textbooks of medicine and physiology that there is a fairly constant relation between rectal and oral temperatures taken at the same time, the rectal being 0.5° to 1° F. higher. Table IIA shows that rectal temperatures of 101° F. are not uncommon in the summer. Stadler (1942) in 233 parallel determinations of resting rectal and oral temperatures of hospitalized convalescent children found differences of $-1°$ to $+3.2°$ F., with oral temperature higher in two cases. Carmichael and Linder (1934) in repeated parallel determinations on 24 normal individuals found differences of $-1.3°$ to $+3°$ F., with several cases in which the oral was higher than the rectal. In our own series of 260 simultaneous resting rectal and oral temperatures the oral was found at a higher level in three cases (Table II, figures in brackets), with a maximum rectal–oral difference of $-0.8°$ F. It would be natural to assume that such a result is due to technical error, but it is safer to suppose that it may be real, although at present the cause is not clear. The analyses in this paper show that out of three sets of data analysed a significant correlation coefficient between oral and rectal temperature was found in two sets only. In general it may be said that at rest the oral and the rectal follow each other, but it is unsafe in any particular case to predict one from the other.

Data obtained from groups of men and from individuals studied over the period March to October suggest that a seasonal change in temperature occurs. Tables VII and VIII show that a rise of 0.5 to 0.6° F. in mean temperature may occur with the onset of hot weather, with a fall at the end of the monsoon period. Indians seem to react in a way similar to British personnel. The mean oral temperature appears to be high at seasons when the mean air temperature is high. This correlation is, however, not marked, and it is possible that the correlation is with the wet-bulb rather than the dry-bulb temperature. Again, analysis of the diurnal temperature records showed a correlation between the variation in oral temperature and the variation in the air temperature. Many factors other than meteorological are concerned in controlling the normal resting body temperature. In women there is a monthly curve of temperature related to the menstrual cycle, and small changes may occur with fluctuation of endocrinal or emotional tone. One cannot therefore expect a high correlation between the body temperature and meteorological conditions. This is particularly true for the individual. The material presented here is small and many more data are required on this subject.

A point of practical interest is the maximum daily range of oral temperature. Textbooks give 1 to 1.5° F. as the normal range. Of 36 diurnal curves (7 a.m. to 2 a.m.) in 14 individuals done between March and October, 36% showed a daily range of 1 to 1.5° F., 55% showed a range of 1.6 to 2.6° F., and 9% reached a range of 3° F. The latter occurred in the months of April and May. Table XV shows a range of 3° F. in an Indian. It is sometimes stated that a hot climate does not affect the range of daily temperature but simply raises its level. The present data do not support this.

Results from the troop trials showed that a march of 3½ hours' duration during the monsoon period raised both oral and rectal temperatures, the latter about 1° F. more than the former (Tables XXI and XXII, D4). The same march done by the same men under very similar meteorological conditions but during a heavy shower showed a fall in oral temperature and a smaller rise in rectal temperature (Tables XXI and XXII, D2 and D3). Prolonged marching may on occasion produce a fall in oral temperature even in the absence of rain, but the rectal temperature invariably shows a rise (Brennemann, 1943). The low mean resting temperature of Serial 6 (Table I) may in part be explained by exposure to rain before temperatures were taken. Cooling of the mouth by the increased respiration due to exertion is not sufficient to explain this phenomenon. It is possible that in conditions where the skin is being rapidly cooled by sweating, air currents, or rain the temperature of the oral cavity tends to follow the skin temperature rather than the internal temperature. Reflex vasomotor phenomena involving the mouth and the neighbouring skin may play a part. The oral temperature cannot be regarded as an accurate index of the internal body temperature, particularly in conditions of activity, and is more affected by external conditions than is the rectal temperature.

Conclusions

Using ordinary clinical thermometers, oral and rectal temperatures of both Indian and British troops during the summer months in North India show levels above those accepted as normal for temperate climates. Oral temperatures up to 100.6° F. and rectal temperatures up to 101° F. may occur in apparently normal individuals. The distribution curve of 894 cases is not significantly skewed.

An individual tends to have his own characteristic daily temperature curve, and on a particular day a group of individuals behave in the same way as regards oral and rectal temperatures.

A significant correlation coefficient is not always found between resting oral and rectal temperatures. In a very small percentage of cases the oral temperature may be actually above the rectal.

Analysis of groups of men and several individuals, both British and Indian, suggests a seasonal trend in the mean oral temperature, which tends to follow the range of air temperature.

Exercise in the rain may cause a fall in the oral temperature. For many physiological conditions the oral temperature may not be a good index of the internal temperature.

REFERENCES

Brennemann, J. (1943). *Amer. J. Dis. Child.*, **66**, 16.
Carmichael, H. T., and Linder, F. E. (1934). *Amer. J. med. Sci.*, **188**, 68.
Castellani, Sir Aldo (1938). *Climate and Acclimatisation*, John Bale, Sons and Curnow, Ltd., London.
Mason, E. D. (1940). *Amer. J. trop. Med.*, **20**, 669.
Radsma, W. T., Meijman, J. T., and Mastenbroek, G. G. A. (1938). *Nederl. Tijdschr. Geneesk.*, **82**, 1432, 4679.
Stadler, H. (1942). *J. Iowa St. med. Soc.*, **32**, 70.
Sundstroem, E. S. (1927). *Physiol. Rev.*, **7**, 320.
Whiting, M. H. (1915–17). *Biometrika*, **11**, 1.

RESULTS OF MASS RADIOGRAPHY OF R.A.F. EX-PRISONERS-OF-WAR FROM GERMANY

BY

A. G. EVANS, M.R.C.S., L.R.C.P.

Squadron Leader, R.A.F.V.R.; Assistant Tuberculosis Officer, Warwickshire and Coventry Joint Committee for Tuberculosis

It was realized that at the termination of hostilities with Germany a considerable number of Air Force personnel would be returning to this country from captivity. A decision was therefore made by the Air Ministry that a Mass Radiography Unit should be installed at the reception camp in the Midlands to which they would return.

All personnel who were fit to travel were brought here for preliminary medical examination and radiography of the chest before going on leave. It should be pointed out, however, that a certain number of cases required direct admission to hospital and were unfit to travel. These cases are not included in our mass radiography figures. It was the policy, so far as was possible, to allow the men first to proceed on leave, then undergo a complete investigation of their pulmonary abnormalities on return. Although there was a certain amount of risk in this, it was considered that, from the point of view of morale, they would respond far more favourably to investigation and treatment when they had seen those from whom they had been separated so long.

Upon return from leave the ex-prisoners selected from the miniature films were re-*x*-rayed on large films and those requiring further investigation admitted to the local regional R.A.F.